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PSEG
Nuclear LLC

10 CFR 50.55a

LR-N13-0064
April 3, 2013

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Salem Generating Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-70 and DPR-75
NRC Docket Nos. 50-272 and 50-311

Subject: **Request for Relief from ASME Code Defect Removal for Service Water Buried Piping**

Reference: (1) PSEG letter LR-N12-0157, "Submittal of Relief Request Associated with the Fourth Ten-Year Inservice Inspection (ISI) Interval Code Edition," dated June 7, 2012, ADAMS Accession No. ML12159A084

In accordance with 10 CFR 50.55a(a)(3)(i), PSEG Nuclear LLC (PSEG) hereby requests NRC approval of proposed relief request SC-I4R-133 for Salem Generating Station, Units 1 and 2. The proposed relief will allow Salem to repair bell and spigot joints in the buried portions of Service Water System piping in lieu of defect removal requirements in ASME Section XI, IWA 4422.1.

PSEG requests approval of the proposed request by April 13, 2014 to support the Spring 2014 refueling outage at Salem Unit 2.

The Code of Record for the Salem Unit 1 fourth ISI interval is the American Society of Mechanical Engineers (ASME) Code, Section XI, 2004 Edition.

Based upon the approval of relief request S2-I4R-123 submitted to the NRC on June 7, 2012 (Reference 1), the code edition for the fourth interval for Salem Unit 2, which begins on November 27, 2013, will also be American Society of Mechanical Engineers (ASME) Code, Section XI, 2004 Edition.

The proposed relief request is provided in Attachment 1 to this letter.

There are no commitments contained in this letter.

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If you have any questions or require additional information, please do not hesitate to contact Mrs. Emily Bauer at 856-339-1023.

Sincerely,

Paul R. Duke, Jr.
Manager – Licensing

Attachment 1 – Relief Request SC-I4R-133

cc: Mr. W. Dean, Administrator, Region I, NRC
Mr. J. Hughey, Project Manager, NRC
NRC Senior Resident Inspector, Salem
Mr. P. Mulligan, Manager IV, NJBNE
Mr. L. Marabella, Corporate Commitment Tracking Coordinator
Mr. T. Cachaza, Salem Commitment Tracking Coordinator

ATTACHMENT 1

Salem Generating Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-70 and DPR-75
NRC Docket Nos. 50-272 and 50-311

Relief Request - SC-I4R-133

Proposed Alternative In Accordance with 10 CFR 50.55a(a)(3)(i)
Alternative Provides Acceptable Level of Quality and Safety

1. ASME Code Components Affected

Code Class:	3
Examination Category:	D-B
Item Number:	D2.10
Description:	Buried portions of the 11, 12, 21, and 22 Nuclear Service Water (SW) Supply and Discharge Headers
Unit:	Salem Generating Station, Units 1 and 2

2. Applicable Code Edition and Addenda

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 2004 Edition.

Salem Unit 2 ends its third 10-year ISI interval on November 27, 2013, and has requested NRC approval (Reference 7.1) to develop the fourth ISI interval in accordance with the 2004 Edition of Section XI.

3. Applicable Code Requirement

ASME Section XI, IWA 4422.1, provides requirements for defect removal that must be satisfied as part of a repair implemented in accordance with IWA-4000. The proposed repair method for degraded bell and spigot joints in buried portions of concrete pipe does not satisfy this requirement. Instead, the proposed repair provides an alternate load path to ensure the structural adequacy of the degraded area, in addition to eliminating the degradation/growth mechanism. This proposed alternative to IWA-4422.1 provides an acceptable level of safety and quality, as required by 10 CFR 50.55a(a)(3)(i).

4. Reason for Request

This request is to allow for the use of a mechanical repair, WEKO seal with steel backing plate, to restore pressure boundary integrity of degraded bell and spigot joints identified during service water system inspections. The degradation is due to corrosion of the carbon steel bell and spigot components caused by exposure to either service water or ground water.

AWWA C301-64, the original construction code for the buried pre-stressed concrete cylinder pipe (PCCP) in the Salem service water system, does not provide sufficient guidance for the design of an appropriate repair for degraded bell and spigot joints. As such, the proposed repair has been designed and evaluated using applicable requirements from both the original construction code and the ASME Boiler and

Pressure Vessel Code, Section III, in accordance with IWA-4221(c). The degraded pipe with repair installed satisfies applicable requirements of the original construction code, ASME Section III, and the Owner's Design Specification. However, installation of the proposed repair does not remove the defect as described in IWA-4422.1. Instead, the repair provides an alternate load path to ensure structural adequacy of the repaired pipe in addition to eliminating additional degradation or expansion of the degraded region. Detailed evaluation of the proposed repair demonstrates that the repair provides an acceptable level of safety and quality, as required by 10 CFR 50.55a(a)(3)(i). In addition, while relief is not being requested under 10CFR50.55a(a)(3)(ii), it should be noted that there are no repair or replacement designs for buried PCCP bell and spigot components qualified for use in nuclear safety-related applications. The only alternative to eliminate the flaw in a degraded bell and spigot joint is to replace the PCCP segment. Due to the nature of the pipe design (overlapping segments), direct replacement with an identical pipe section is not possible and would necessitate development of an alternate design.

Under the preventative maintenance (PM) program, Salem routinely monitors and inspects service water and related Ultimate Heat Sink (UHS) components in accordance with the requirements of NRC Generic Letter (GL) 89-13 (Service Water Problems Affecting Safety Related Equipment). Previous inspections of the service water piping at Salem Units 1 and 2 have identified general corrosion and pitting corrosion in some bell and spigot joints due to improper application/degradation of protective coatings. Based on the results of structural evaluation of the bell and spigot joint, PSEG has determined that joints with wall thickness less than 0.1 inch are not capable of performing their design function and must be repaired. In the event that a degraded joint is identified, PSEG proposes to repair the joint by:

1. Cleaning and re-coating the degraded portion of the bell band to prevent future corrosion.

2. Ensuring the degraded joint is capable of carrying the pipe design axial loading through either measurement of the bell wall thickness (and verification against established acceptance criteria) or by visual inspection of the external harness assembly (which normally carries the longitudinal pipe loads) to verify that it is intact and functional. If the bell wall thickness acceptance criterion for axial load carrying capability (0.042 inches) is not met, verification that the harness assembly is intact is required to demonstrate the joint is capable of carrying the longitudinal pipe load. Additional details and bases are provided in Section 5.3.

3. Installing a WEKO seal with structural backing plate over the joint inside diameter to: (a) restore the pressure boundary by carrying the radial and hoop loads, and (b) prevent additional exposure of the joint to the Service Water environment.

5. Proposed Alternative and Basis for Use

5.1 Current Design Description

The buried service water piping at Salem Units 1 and 2 consists of 24-inch PCCP with a steel core. The PCCP pipe segments are connected to each other with bell and spigot joints to provide adequate flexibility (extensibility and articulation) to accommodate pipe movement during operation and design basis scenarios.

The PCCP installed consists of a spun concrete core inside a 10 gage carbon steel cylinder. Pre-stressing wire is wrapped around the cylinder and tensioned, placing the steel cylinder and core into compression. Mortar is applied to the outside of the pipe to protect the wire and cylinder from damage and corrosion. In locations where the use of pre-stress wire is not feasible (e.g. elbows, tees, and flange adapters), the 10 gage cylinder and pre-stress wire is replaced with a thicker steel cylinder. These components are referred to as "specials."

In both cases, external harness bolts are installed to carry the axial pressure load.

A description of the two joints (PCCP-PCCP and PCCP-Special) and harness bolt configuration follows.

5.1.1 Pre-Stressed Concrete Joint Configuration

A sketch of a typical PCCP bell and spigot joint is shown in Figure 1. The key elements of the pre-stressed concrete bell and spigot joint are as follows:

- A concrete core 1.5 inches thick is spun inside a steel cylinder 0.1345 inch thick (10 gage) with an outside diameter of 27 inches.
- The steel cylinder is wrapped with tensioned steel wire to pre-stress the concrete core and the steel cylinder. The wires are 0.162 inch in diameter (8 gage) and are installed with a tensile stress of 173,250 psi. The wire is wrapped 22.4 times per axial foot on the liner.
- After the cylinder/concrete core is pre-stressed, mortar is painted on the cylinder OD to protect the wires and cylinder. The mortar is nominally 13/16 inch thick.
- At one end of the pipe, a steel spigot is welded to the end of the cylinder. The spigot includes a groove for installation of an O-ring seal.
- At the other end of the pipe, a steel bell is welded to the end of the cylinder. The steel bell includes 24 bell bolts (0.75 inch-10UNC-2A) around the circumference. The bell bolts provide longitudinal strength for the joint in the event of failure of the harness bolt assembly. The steel bell is pre-stressed with three wraps of wire. The first two wraps are placed at half load (i.e. a wire stress of 86,625 psi). The mortar over the joint is approximately 2.2 inches thick and includes a 13 gage (0.092-inch diameter) 2-inch x 2-inch wire mesh over the bell to prevent shrinkage cracking during fabrication. This mesh provides negligible structural strength to the joint.

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5.1.2 Special Joint Configuration

A sketch of a typical special joint is shown in Figure 2 (Note that the figure shows the configuration for both the bell and spigot when used with non pre-stressed pipe – "specials." This is provided for convenience; only one side of the joint would typically use a special). The key elements of the special bell and spigot joint are as follows:

- The inside of the pipe is lined with 1-inch thick concrete inside a 0.5 inch thick steel cylinder. The concrete core has an inside diameter of 24 inches and an outside diameter of 27 inches.
- The steel cylinder is not pre-stressed with wire.
- The outside of the steel cylinder is coated with mortar painted on the cylinder OD to protect the cylinder. The mortar is nominally 13/16 inch thick.
- At one end of the pipe, a steel spigot is welded to the end of the cylinder. A grooved ring holding a pressure retaining gasket is welded to the spigot.
- At the other end of the pipe, a steel bell is welded to the end of the cylinder. The steel bell includes 24 bell bolts (3/4 inch) around the circumference. Approximately 2.2 inches of mortar is applied to the bell OD and includes a 13 gage (0.092-inch diameter) 2-inch x 2-inch wire mesh over the bell to prevent shrinkage cracking during fabrication. This mesh provides negligible structural strength to the joint.

5.1.3 Harness Bolt Assembly Configuration

The bell and spigot joint is normally installed with the spigot inserted several inches into the bell. The twenty-four ¾-inch bell bolts are not normally engaged with the shear edge of the spigot to react the axial pipe loads. The joints are designed and installed to permit a minimum of two inches of axial extension and 1° of articulation.

Special joints, which are installed at elbows, end pieces, and other locations where the piping run starts, stops, or changes direction, include two external harness assemblies, one on each side of the pipe joint. These harness bolts run the entire length of straight pipe, from special joint to special joint, and carry the axial pipe loads. The harness bolts are 2-inches in diameter, with a minimum tensile strength of 98 ksi. The harness bolts are attached to the pipe specials using a heavy hex nut and clevis arrangement. A typical harness bolt assembly arrangement is shown in Figure 3.

ATTACHMENT 1

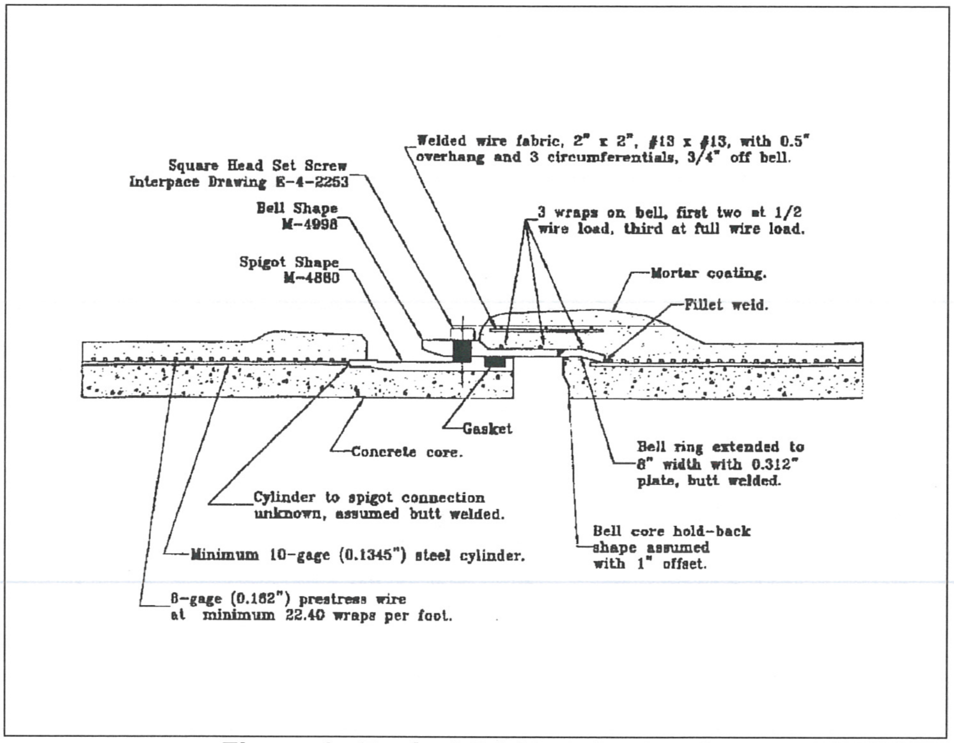

Figure 1 - Typical PCCP Joint Configuration

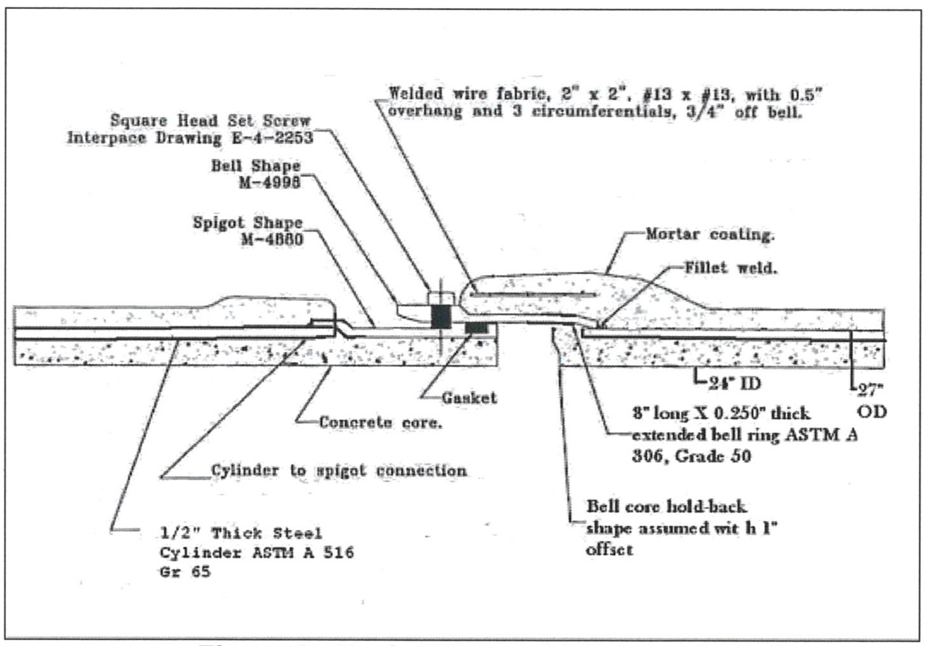

Figure 2 - Typical Special Joint Configuration

Note: This figure shows a non pre-stressed "special" bell connected to a non pre-stressed "special" spigot. This configuration is not installed, but is shown for compactness (i.e., to present both the "special" bell and spigot configurations in one figure).

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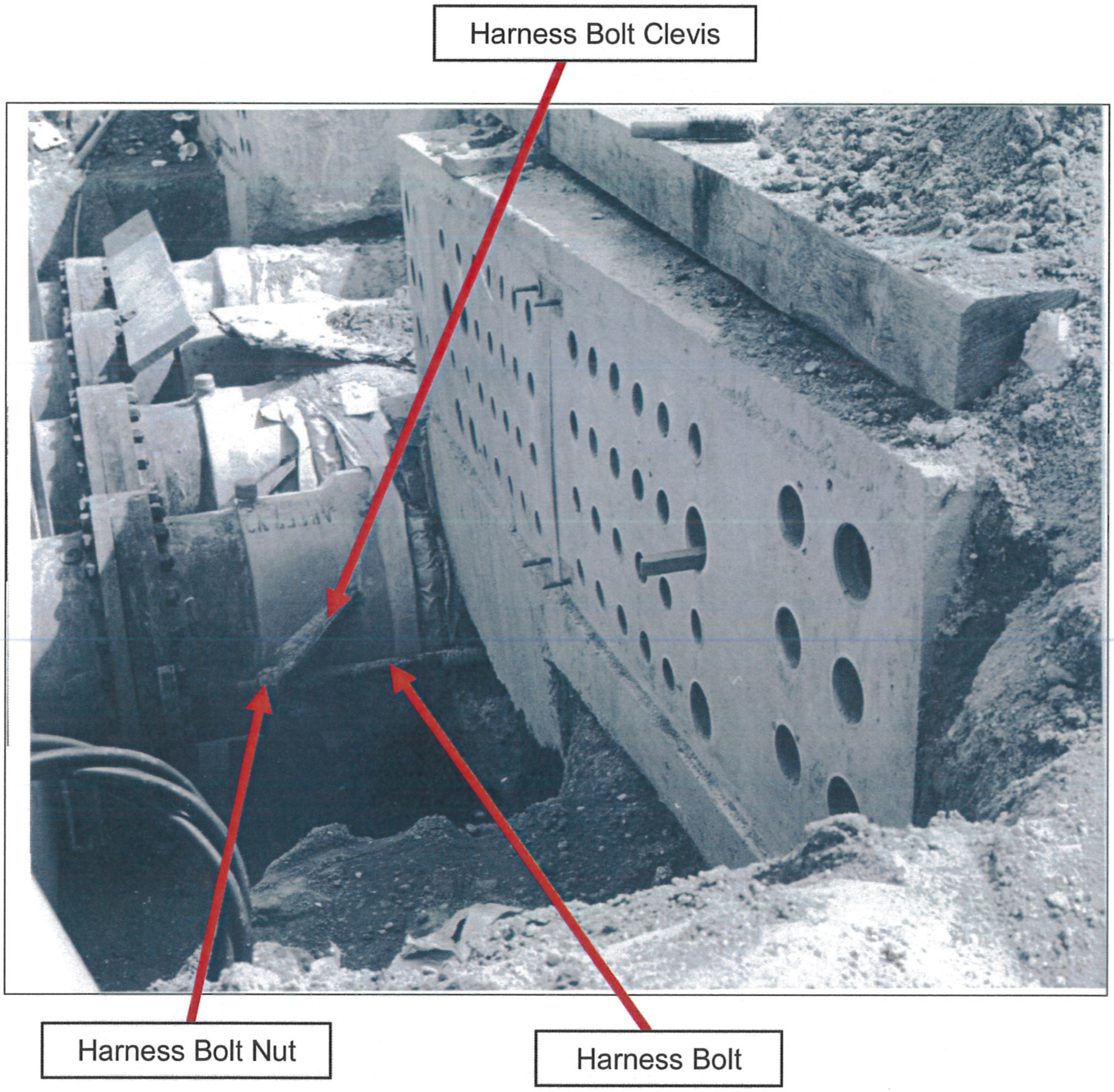

Figure 3 - Photograph of Harness Bolt Anchorage

5.2 Description of Proposed Repair/Alternative

PSEG Nuclear proposes to repair degraded bell and spigot joints through use of a mechanical repair system installed on the inside diameter of the pipe, covering the degraded joint to prevent exposure to the service water environment and providing pressure boundary integrity. Use of the WEKO seal with structural backing plate is based on the following bell wall thickness acceptance criteria:

- Wall thickness > 0.1 inch – Structural evaluation of the bell and spigot joint has demonstrated that a minimum general bell wall thickness of 0.1 inches provides sufficient capacity for all design pipe loads (both axial and hoop). Failure to meet this criterion requires repair of the joint
- Wall thickness > 0.042 inches – Structural evaluation of the bell and spigot joint shows that with a minimum general bell wall thickness of 0.042 inches, the joint is capable of carrying the design axial pipe load without crediting the external harness assembly. Therefore, a measured wall thickness between 0.042 inches and 0.1 inches requires repair (WEKO seal with structural backing plate) to restore hoop capacity, although inspection of the harness assembly for axial capacity is not required.
- A measured wall thickness below 0.042 inches requires both installation of the WEKO seal with backing plate and inspection of the harness assembly to ensure it is intact and capable of carrying the design pipe load.

The mechanical repair system (WEKO seal with structural backing plate) provides hoop strength and leak-tightness at the joint and prevents exposure of the degraded joint to service water. The WEKO seal repair does not provide any axial strength to the joint. The seal is held in place with four retaining bands. The double-wide WEKO seal configuration (used for this repair) is shown in Figure 4. Key elements of the WEKO seal are:

- A 316 stainless steel backing plate is centered over the joint gap and covered by an EPDM double-wide rubber seal. The thickness of the backing plate is determined based on the width of the gap that the plate is covering (Reference 7.9 shows that a 3/16 inch plate thickness is sufficient for the maximum gap size of three inches).
- Two 2-inch wide, 1/8 inch thick radially expanding retaining bands are placed at each end of the seal. The outer set of retaining bands, which are forced against the seal using a hydraulic expander, compress the seal into the concrete core while the inner set of bands compresses the seal and steel sleeve into the core. This design allows for both radial and axial growth in the pipe.

ATTACHMENT 1

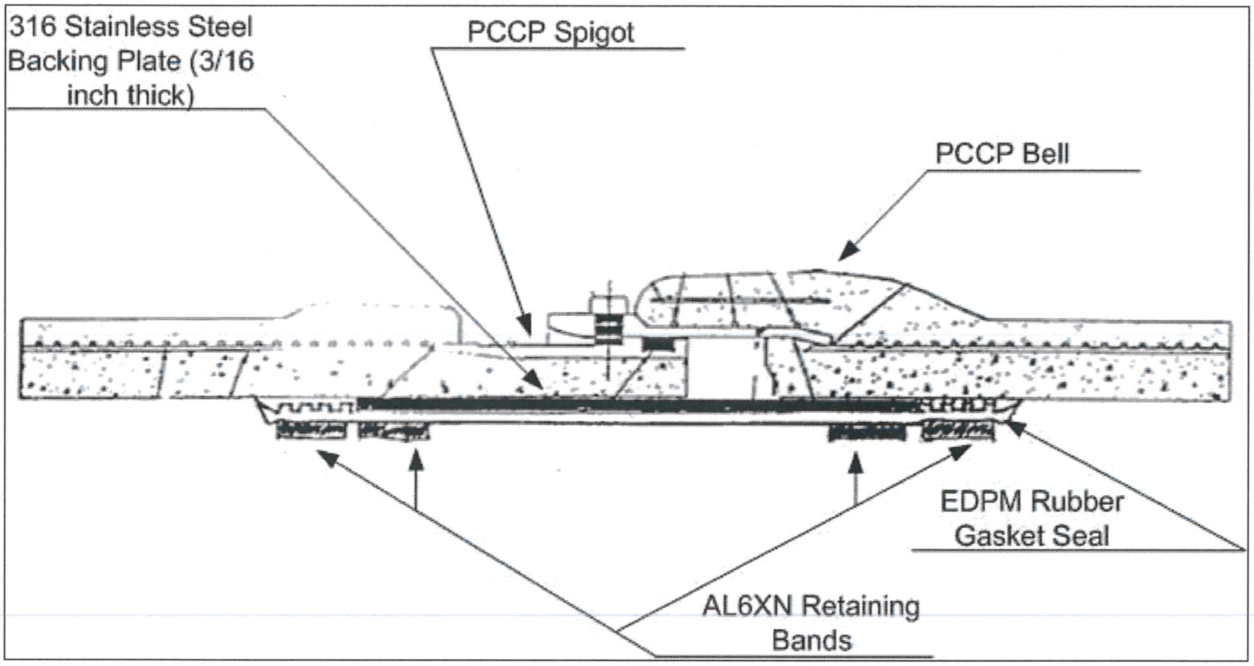

Figure 4 - Double-Wide WEKO Seal Configuration

ATTACHMENT 1

5.3 Basis for Use

5.3.1 Bell-and-Spigot Joint Design Requirements

Design requirements for PCCP bell and spigot joints installed in the service water headers are provided in pipe specification S-C-MPOO-MGS-0001 and evaluation S-C-SW-MEE-1975 (References 7.3 and 7.11). The service water design pressure and temperature are 200 psig and 160°F, respectively. The bell and spigot joints form the piping pressure boundary and are designed to provide two inches of axial deflection and one degree of articulation. Axial piping loads due to internal pressure or seismic are carried by the external harness assembly. The bell bolts, identified as set screws in Figures 1 and 2, provide axial restraint in the event of a failure of the harness assembly. The harness assembly is designed to carry the full design basis seismic loads.

5.3.2 Repair Design Evaluation

The installed WEKO seal assembly (with backing plates) provides three key benefits:

- Restoration of the pressure boundary with the installed backing plates.
- Maintenance of required joint flexibility.
- Elimination of future bell or spigot degradation by (1) cleaning the components and re-applying the protective epoxy coating, and (2) preventing additional exposure to the brackish service water environment.

Axial pipe loads are not carried by the WEKO seal repair. Implementation of the WEKO seal repair requires verification that the pipe joint (bell and/or harness assembly) is capable of carrying the axial pipe load. This is accomplished through measurement of the bell wall thickness or inspection of the external harness assembly, as described in Section 5.2.

Material Assessment

Qualification of the WEKO seal for use in the Salem service water system is provided in Vendor Technical Document (VTD) 325595 (Reference 7.5), which provides the basis for material acceptability. The installed WEKO seal assembly consists of:

- An EPDM rubber sheet that is resistant to seawater up to 200°F and provides excellent serviceability in cold water and is aging resistant. In addition, EPDM has good resistance to sodium hypochlorite, which is used in the service water system to control bio-fouling.
- 3/16 inch thick 316 stainless steel backing plates. The backing plates are isolated from the service water environment by the EPDM seal, precluding degradation due to microbiologically induced corrosion (MIC), a known degradation mechanism in the service water environment.
- The retaining bands, which are exposed to the service water environment, are fabricated from AL6XN, a stainless steel alloy containing 6% Molybdenum. AL6XN is the material of choice for use in the Salem service water system due to its excellent corrosion/erosion resistance in that environment.

ATTACHMENT 1

Hydraulic Assessment

Installation of the WEKO seal increases the hydraulic resistance of the piping by a very small amount. An evaluation of the impact of WEKO seal installation on service water system performance concluded that service water flow requirements are satisfied with sufficient margin (Reference 7.10). As part of the modification process, the service water system thermal hydraulic model (Reference 7.6) will be reviewed and updated as necessary following WEKO seal installation to ensure configuration management control.

Structural Assessment

PSEG has performed evaluations to demonstrate that the WEKO seal design is structurally adequate under design basis and service conditions. In addition, the impact of the WEKO seal on stresses in the adjacent PCCP has been evaluated (Reference 7.7). Key evaluations and conclusions are summarized below.

- The WEKO seal satisfies applicable design requirements under seismic loading.
  - The seismic acceleration required to unseat the seal assembly is 68.3g, compared to the maximum ground acceleration of 0.2g (Reference 7.5).
  - Installation of the seal assembly will not adversely affect the pipe joint's ability to permit seismically induced angular or axial deflections (Reference 7.5). This conclusion has been supplemented by qualification testing provided in Reference 7.8, which demonstrates that a bell and spigot joint with the WEKO seal installed could accommodate maximum expected deflections.

- Structural evaluation of the WEKO seal closure mechanism (retaining bands and push tab) based on installation and design loads is documented in References 7.5 and 7.8:
  - Maximum compressive stress on the retaining band is 64% of yield strength.
  - Maximum contact pressure at the retaining band of 309 psi is less than the critical buckling pressure of 418 psi.
  - Maximum shear stress in the push tab welds during installation is 66% of the allowable stress.
  - The impact of thermal expansion on retaining ring is negligible, based on a temperature difference of 90°F.

- Bending stress in the backing plate is evaluated in References 7.5 and 7.7. These calculations show that the bending stress satisfies applicable acceptance criteria (Stress Index=0.85) assuming a 3/16 inch plate and the maximum bell-to-spigot gap.

- The stability of the WEKO seal under hydrodynamic loading is evaluated in Reference 7.8. The evaluation concludes that the friction load due to a single retaining band is sufficient to resist hydrodynamic loads. WEKO seals have been installed as a preventative measure at all joints in the service water supply headers. Visual inspections completed during GL 89-13 inspections have shown that the WEKO seals have remained intact.

- The WEKO seal (with steel backing plate) does not carry axial piping loads. As such, use of this repair to restore pressure boundary integrity (excluding axial loads) requires verification that the joint remains capable of carrying axial pipe loads. Finite element analyses were performed and demonstrate that both configurations of the bell and spigot joint (PCCP and Special) are capable of carrying the design basis axial pipe load with a minimum general bell wall thickness of 0.042 inches (References 7.4 and 7.9). As such, installation of a WEKO seal (with structural backing) in a joint with general wall thickness less than 0.042 inches requires verification that the harness assembly is intact and capable of carrying the design axial pipe load. The harness assembly is designed to carry axial pipe loads; axial loads would only be carried by the bell and spigot if the harness assembly failed.

- A finite element analysis of the PCCP joint including WEKO seal was performed to evaluate the impact of WEKO seal installation on PCCP stresses (Reference 7.7). Key conclusions of this evaluation are:
  - The minimum net compressive stress in the core (1,114 psi) is greater than the applicable AWWA C304 acceptance criterion (271 psi). Therefore, installation of the WEKO seal does not result in unacceptable loss of compression in the concrete core under design pressure conditions.
  - The maximum principal tensile stresses in the mortar, which is installed after pres-stressing of the core and is not in compression, is 185 psi, which is less than the applicable AWWA C304 acceptance criterion of 470 psi. Therefore, installation of the WEKO seal will not overstress the mortar, demonstrating that serviceability of the mortar will not be impacted.

5.4 Conditions for Using Alternate Repair Method

Installation of the WEKO seal mechanical repair system with steel backing plate to restore pressure boundary integrity of a degraded bell and spigot joint has the following conditions for use:

- Prior to installation of the WEKO seal, the degraded joint must be thoroughly cleaned and re-coated with an approved epoxy sealant. Cleaning and re-coating, in conjunction with seal installation, prevents future exposure of the joint to the service water environment, ensuring that there will be no additional degradation of the joint.
- Following installation of the WEKO seal with steel backing plate, pressure testing of the repaired service water joint (i.e., with WEKO seal and structural backing installed) is required.
- The WEKO seal with steel backing plate does not carry axial piping loads. Use of the repair system as a structural repair with bell wall thickness values below 0.042 inches requires visual inspection of the external harness assembly to ensure it is intact and functional. Additionally, a VT-2 examination of the exposed portion of piping is to be performed for evidence of leakage after the system is placed back in service.
- Periodic inspections of the degraded joint and the installed WEKO seal will be performed in conjunction with GL 89-13 inspections to ensure that (1) degradation of the joint has not continued, and (2) the WEKO seal is intact and undamaged. The external harness assembly will also be periodically inspected in the area of the repaired joint, if credited for axial load carrying capability. VT-2 examination of the

exposed portion of piping is to be performed any time external harness assembly inspections are performed in the area of the repaired joint.

The installation of the proposed repair system provides a robust and reversible method to repair degradation of bell and spigot joints in the service water buried piping which provides an acceptable level of quality and safety, as required by 10 CFR 50.55a(a)(3)(i).

6. Duration of Proposed Alternative

Authorization of this alternative repair is requested for the remainder of plant life for Salem Units 1 and 2.

7. References

7.1. PSEG letter LR-N12-0157, "Submittal of Relief Request Associated with the Fourth Ten-Year Inservice Inspection (ISI) Interval Code Edition," dated June 7, 2012.

7.2. Salem Generating Station Updated Final Safety Analysis Report.

7.3. Specification S-C-MPOO-MGS-0001, "Salem Piping Specification," Revision 19, Contains Schedule SPS28, "Underground Service Water, Fresh and Salt Water in Yard (Including Fire Protection)," Revision 4.

7.4. VTD 326511, Sheet 1, "Evaluation of Salem PCCP Service Water Pipe," Revision 1.

7.5. VTD 325595, "Qualification of Internal Mechanical Seal Assembly," Revision 1, Contains Proto-Power Corporation Calculation 02-043, "Qualification of Internal Mechanical Seal Assembly," Revision A.

7.6. Calculation S-C-SW-MDC-1967, "Service Water System Thermal Hydraulic Model," Revision 7.

7.7. VTD 327717, Sheet 1, "Evaluation of WEKO Seals on Bell and Spigot Joints," Revision 1.

7.8. Calculation S-1-SW-MDC-1906, "Salem Service Water Underground Pipe Repair," Revision 1.

7.9. VTD 325626, Sheet 0, "MPR-2449: Evaluation of Salem Station Concrete Service Water Pipe Specials," Revision 1.

7.10. Modification 80105766, Revision 0, Supplement 01, "Sensitivity Analysis with Added WEKO Seal Resistance," Revision 0.

7.11. Evaluation S-C-SW-MEE-1975, "Salem Units 1 and 2 Concrete Service Water Pipe Joints Acceptance Criteria," Revision 0.